Critique of the DEIS: Problems with their Vibration Assessment

The DEIS Executive Summary Table S-1 breaks down the various aspects of the VAT project and their impacts on existing vibration levels. For vibration levels during construction, the DEIS admits that certain construction activities will exceed FTA's criteria for structure damage and human annoyance, but it maintains that these construction methods are intermittent and localized and, as such, mitigations could be applied. The Executive Summary indicates that, post construction, none of the build alternatives are predicted to exceed the FTA thresholds for vibration impacts.

The vibration assessment document, Appendix F to the DEIS, defined the VAT project as occurring from 2nd St to 11th St along Va Ave. The vibration assessment involved the evaluation of the existing vibration environment at three locations in May of 2012. The assessment was performed in a single day, capturing 5 train passings. Measurements were taken at the east portal, the 300 block of Virginia Ave to assess the CQ properties, and at the Marine Barracks facilities along Virginia Ave. Each location utilized a set of two sensors, one closer to the current track line (as allowable without interfering with existing infrastructure) and one further away. Comparing the difference in levels at the two locations allowed the assessment team to empirically estimate the attenuation of the soil in the given geographic location. Measurements taken at the east portal are source levels representative of a train at grade, while measurements at the other locations are levels representative of a train in the tunnel. Background levels (i.e. vibration when a train was not present) at all three sites ranged from 0.005 to 0.010 in/sec (ppv), or 62 to 68 VdB. The assessment observed that, on average, a train passing by the east portal sensors caused a vibration level of 0.06 in/sec (ppv) or 84 VdB. At the 3rd street and Marine Barracks sites, a maximum level was measured at 0.015 in/sec (ppv) or 72 VdB. The 12 VdB difference between the sites is indicative of the difference in how vibrations travel when the source is on the surface (as at the east portal site) and produces mostly surface waves compared to when the source is beneath the surface (as at the 300 block and Marine Barracks sites) and produces both body and surface waves.***

Post-Construction Impacts:

The vibration assessment utilized the May 2012 measured levels both to estimate the attenuation of the geology in the vicinity of the VAT and to estimate the source levels of the new train traffic in the tunnel(s). The estimation also relied on limit of disturbance, or LOD, drawings and survey information to determine the proximity of the new tunnel(s) to existing structures. The assessment concluded that, because the closest structure would be 44 ft from the new tunnel(s) regardless of which build alternative was chosen, no adverse effects would be attributable to new train traffic. The main errors with this assessment are as follows:

- While the assessment estimated the new train vibration source levels at twice the highest level measured at the east portal in May 2012, this accounts only for the additional track (i.e. two trains utilizing the new tunnel(s) at the same time) and does not account for the actual worst case scenario where two double stacked trains are utilizing the new tunnel(s) at the same time. Therefore, the levels calculated for Table 5-5 should be higher than published. Table 5-5 set the impact line from a train "at grade" on a structure at the same elevation as the track (i.e., both on the same surface) at 23 ft for

structural damage and 41 ft for potential human annoyance. This means that any structures closer than 23 feet to the source of the vibrations have the potential for structural damage and anyone within 41 feet of the source of the vibrations will experience the vibrations at a level of potential human annoyance. Table 5-5 set the impact line from a train "in tunnel" on a structure on the surface (i.e., the train track and structure are at different elevations) at 20 ft for structural damage and 36 ft for potential human annoyance. This means that any structures closer than 20 feet to the source of the vibrations have the potential for structural damage and anyone within 36 feet of the source of the vibrations will experience the vibrations at a level of potential human annoyance.

- The Arthur-Capper Senior center at 5th street and Va Ave presents a unique scenario in which part of the building (the north side) will be affected both by surface and body waves and, as such, cannot be assessed by Table 5-5's “train in tunnel” limits alone. The building exists on a plot of land with a unique slope that results in the residents on the bottom level of the north side of the building being more in line with the tunnel's track level than any other structure along Va Ave. As such, the residents are currently and will be more susceptible to vibrations from the new trains. The DEIS does not provide sufficient information to determine the distance of the north side of the senior center to the proposed tunnel(s) locations and whether that distance falls with the impact limits identified in Table 5-5.

Construction Impacts:

The assessment determined that 44 ft is the closest point between an existing structure and the track edge for all build options. Without specific details of the construction methods to be utilized, vibration from a set of known construction methods was assessed. The greatest impact from an assessed construction method was from a Vibratory compactor/roller. With respect to damage to structure from vibration levels, the impact distance was set to 33 ft. With respect to potential human annoyance, the impact distance was set to 59 ft. Evaluating the closest existing structure within these limits, the assessment concluded that there is no potential for structural damage and limited potential for human annoyance due to construction impacts and that the limited potential for human annoyance can be mitigated by using a number of possible solutions fully detailed in the assessment. The main errors with this assessment of construction impacts are as follows:

- If the 44 ft distance determination were accurate, the closest building would not have the potential for structural damage, but it would be well within the limits for potential human annoyance. However, the DEIS Summary sets concepts 2 and 4 at a mere 33 ft from a representative existing building (i.e., at 3rd street and Va Ave) for a temporary run around track. Nearly all methods of construction have a potential human annoyance limit that exceeds 33 ft (the exception being a Jackhammer at only 23 ft). With regard to potential structural damage, sonic sheet drivers and the vibratory compact/roller have limits at 30 ft and 33 ft, respectfully.

- Using the 44 ft distance determination, trains running through the temporary track are estimated to not have the potential for structural damage or human annoyance. However, the 33 ft distance representing concepts 2 & 4 falls within the 36 ft limit of potential human annoyance estimated

by Table 5-5. Reductions to the vibration impact in Table 5-5 estimated from a single train in the temporary track would still result in distances close to the 33 ft standoff of the existing building.

Finally, it is noteworthy that the mixed-use structures between 7th and 9th streets show the structural impact and human annoyance impact lines crossing many properties (see figures at the end of the vibration assessment). It is unclear if those figures are related to construction levels or post-construction levels; however, businesses and residents should raise concerns about vibration resulting in either scenario. In addition, the doggie daycare is located within the same area, and it has been well-documented that animals are more susceptible to vibration (and noise), such that the construction and post-construction environments will have an adverse affect on the animals being cared for at that facility.

***Ground borne vibrations, or vibrational energy traveling the Earth's layers, can generally be broken into two distinct categories of waves: body waves and surface waves. Body waves travel through the interior of the Earth while surface waves travel along the Earth’s surface. Body waves manifest as P-waves, which are compressional waves that are longitudinal in nature, or as S-waves, which are shear waves that are transverse in nature. Body waves travel in all 3 primary directions (i.e., on the x, y, and z axes) and as such dissipate or attenuate faster than surface waves. Conversely, surface waves travel along the Earth's surface radiating outward from the source. While surface waves can have some impact and a shallow depth compared to body waves, they are estimated and modeled as traveling only in 2 dimensions (i.e. on the x and y axes). The attenuation of surface waves is slower than that of body waves, thus causing the impact of surface waves to extend farther from the source than body waves. When a train travels “at grade,” or on the surface, it is primarily exciting surface waves. When a train travels in a tunnel, it will excite surface waves along the tunnel floor, which will disperse into the surrounding earth as body waves given that the train will be traveling at some depth below the surface. The simple act of lowering an “at grade” track into a tunnel will reduce the vibrational impact in the surrounding area since the energy will be shifted into more body waves than surface waves, which will attenuate more efficiently due to the Earth's layers.